Art. XVI.—*The Geology of Mount Macedon, Victoria.*

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(With Plates XI.-XVII.).

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I.—Introduction.

Mount Macedon is an isolated mountain ridge which, though seen at a distance of 40 miles, is one of the most conspicuous features in the views from Melbourne. Its hummocked crest rises abruptly from the broad basalt plains at its foot; and its outline stands boldly on the skyline above the level plains and dissected plateaux, which combine with it to form the northern and western rim of the great Melbourne basin.

The interest of the appearance of Mount Macedon is heightened to a geologist by the uncertainty as to its age and structure expressed on the maps of the Geological Survey of Victoria. The rocks are described as "Trap or Hypogene," and in the official geological handbook to the State, its age is suggested as probably late Palaeozoic, though on admittedly inadequate grounds.

This uncertainty is unfortunate, for a short acquaintance with the geology of the Melbourne area shows that Macedon is one of a series of similar igneous blocks, whose age and stratigraphical relations must be determined before the volcanic history of Victoria can be satisfactorily written.

In my first visit to Mount Macedon I had the privilege of the guidance and company of Mr. H. R. Hogg and Professor Spencer. I have also to express my thanks for much assistance in a subsequent visit to Mr. H. J. Grayson, who has prepared the photographs of the rock sections, as well as the sections themselves. I am indebted to Professor Orme Masson and Mr. R. J. Lewis for analyses of two Macedon Rocks; to Mr. H. C. Jenkins, A.R.S.M., for the analyses of allied rocks from the Dandenongs and Blacks' Spur; and to Mr. A. Everett for some advice as to the geographical nomenclature. Mr. E. T. Prior, of the Mineralogical Department of the British Museum, has very kindly examined some rock sections and given me the benefit of his opinion on some doubtful points, which is of especial value owing to his careful study of the allied rocks of Abyssinia.

II.—The Geographical Features.

Mount Macedon was discovered by Hume and Hovell in 1824. They saw it from Mount Disappointment, and named it Wentworth, after the distinguished champion of Australian liberty. The mountain was, however, first visited by Sir Thomas Mitchell, during his memorable journey from Sydney through Australia Felix. He ascended the mountain on 30th

September, 1836, in order to connect his route in northern Victoria with the southern coast. From the summit he saw Port Phillip, and, neglectful of Hume and Hovell's priority, he adopted for the mountain a new name suggested by that view. Mitchell explains, "I gave it the name of Mount Macedon with reference to that of Port Phillip" (12, vol. ii., p. 283). He adds that "Geboor is the native name of this hill, as since ascertained by my friend, Captain King, and is a much better one."[1]

Mount Macedon consists geographically of one long ridge, which on the west, south and north rises abruptly from the surrounding country. The ridge stands on a platform of Ordovician rocks, which are exposed beneath the Macedon series on all sides except the north-west. There, according to Aplin's map, the "traps" sink below the basalts of the "upper volcanic series"—the "Pliocene" basalts of the Geological Survey.

The "traps" of the Macedon group are represented on the survey map as covering an approximately rectangular area, the sides facing the cardinal points. The margins, however, are irregular, as inlets of Ordovician rocks are exposed on the floor of the deeper valleys. The main Macedon ridge runs obliquely across the area from the south-western corner to the eastern side. It is about five miles long and has three main summits. The name of Mount Macedon is often restricted to the south-western shoulder of the main ridge; this point is marked by the cairn of the Trigonometrical Survey. The height is 3325 feet. To the north-east of the trigonometrical station the crest descends slowly; it rises again to a central hummock, known as the Camel's Hump.[2] Hence the ridge descends again to another saddle, rising slightly to the eastern shoulder, the third conspicuous point in the view from Melbourne. The eastern shoulder is less abrupt than the south-western; beyond it a lower ridge continues towards the the east, where Macedon ends at the peak of Mount Eliza.

The northern face of the ridge is steep and comparatively unbroken. The southern side is a long slope, which has been cut by a series of deep valleys into several spurs running southward from the main ridge. The most westerly of these spurs begins at the Camel's Hump and lies between the Turritable Creek to the west and the Willimigongong Creek to the east; it may be called the Upper Macedon Spur, as that village is situated upon it. The second spur is on the eastern side of the Willimigongong, and its most conspicuous feature is its southern shoulder, Mount Towrong (2820 feet); it may be called the Towrong Spur. Eastward again is the valley of Baringo Creek. Then follows the third spur, which leaves the main ridge at the height of 2720 feet at "Mahoney's Corner" and runs through Cherokee's to Mount Robertson; it may be called the Cherokee Spur. The eastern side of this spur is formed by the "Running Creek," a small stream which rises near Kerr's Mill, and flows through a gap between Mount Teneriffe to the south and Mount Charlie to the north, and joins the Bolinda Creek. These two hills are capped by Kerrie conglomerates and geologically are not part of the Macedon group. To the north of them is Mount Eliza, which forms the eastern end of the main ridge.

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[1] This name is given as a synonym on Arrowsmith's Map of S.E. Australia. Parl. Pap. Gt. Brit., 1852-3, vol. xvi., p. 97.

[2] The exact height of the Camel's Hump is doubtful; it is generally regarded as slightly higher than the south-western shoulder.

On the plain to the north of the main ridge are several hills, which belong geologically to Mount Macedon. They are the Hanging Rock; Dryden's Hill or the Jim-Jim, north-west of Newham; Brock's Monument, north-east of the eastern shoulder; and several unnamed hillocks. The ridge south of Mount William is mapped as "Hypogean Trap" on the Geological Survey maps, but the rock in question has no connection with the Macedon series.

The general topography of the mountain, with the nomenclature adopted, is shown on the accompanying shetch map (Fig. 1). The nomenclature of the peaks is somewhat confused, but I have adopted the names used locally. The Camel's Hump is marked as Mount Diogenes on the parish map and on the Geological Survey map, whereas on the Index map of the Geological Survey the name Alexander's Crown is apparently given to this peak. The Hanging Rock is called Mount Diogenes on the parish map of Newham, Dryden's Rock and the Hanging Rock being given as synonyms. The name Dryden's Hill is now generally accepted for the ridge to the north-west of Newham Hotel; it is thus marked in the county map of Dalhousie. This hill is also known as the Jim-Jim.

Brock's Monument is named Alexander's Head on Skene's[1] Map of Victoria and the Index map of the Geological Survey.

III.—Geological Literature on Macedon.

The list of geological literature on Mount Macedon is brief. The first reference is that of Mitchell, according to whom the mountain is formed of "syenite so whitened with the weather as to resemble sandstone."[2]

The next important contribution to the geology of the mountain is the map prepared by C. d'O. Aplin under the direction of Dr. A. R. C. Selwyn (1). This map, which is on the scale of two inches to the mile, shows the boundaries of the Macedon igneous rocks, but gives little information as to their relations and variations. The whole series is represented by one colour, and is described as "trap or hypogene"; a note on the Camel's Hump states that the rock there is a porphyritic felspar trap, while the rock of the south-western shoulder (the Mount Macedon of the map) is said to be a non-porphyritic felspar trap. The only interruption in the area of the "traps" is the occurrence of a granite dyke on the western flank of the mountain.

After the publication of the Geological Survey Map, brief descriptions of some of the Macedon rocks were given in Selwyn's Catalogue (No. 19, pp. 12, 13, 65, 94, 95). The rocks of the Camel's Hump, the Hanging Rock, Brock's Monument, and the eastern flank of Macedon were all classed as plutonic rocks and were named "felspar porphyry." The most important information about the Macedon rocks given in this Catalogue is an analysis of the "Camel's Hump" rock, which is returned as having the high soda percentage of 10·17. The interest of this determination was, however, apparently overlooked.

In 1894 there was a proposal partially to adopt Mitchell's original name for the Macedon rock; for Cosmo Newbery, in his "Descriptive Catalogue of Victorian Rocks" (15, p. 26), described Brock's Monument as composed of syenite porphyry containing hornblende and very glassy looking orthoclase.

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[1] Everett's Edition of Skene's 8 miles to the inch Map. Surv. Geol. Vict.

[2] The determination of the rock as syenite is due to Lonsdale. Cat. Aust. Rocks in Coll. Geol. Soc., Parl. Pap., Gt. Brit., 1852-3, vol xvi., p. 433. Lonsdale also determined the rock at the base of the north side of the mountain as a "decomposed gneiss."

In 1895 Mr. R. A. F. Murray (14, pp. 22-23) accepted the name of syenite porphyry and advanced the view that this rock is intimately associated with the granites which occur below it.

The last contribution to the geology of Mount Macedon is a paper by Mr. E. G. Hogg (5, pp. 93-96), in which the rocks of the Turritable Creek waterfall, the Camel's Hump, the Hanging Rock and Brock's Monument are determined as trachyte. Hogg expressed the opinion that the age of the Macedon rocks is almost certainly post-Silurian, and probably later than the Permo-Carboniferous, owing to their absence from the glacial conglomerates of that period.

IV.—The Petrography of the Macedon Rocks.

Most of the Mount Macedon ridge is covered by gum forest, thick scrub, and a mantle of deep, rich soil. Rock exposures are scanty and small; accordingly a detailed geological map is impossible, and the determination of the relations of the various rocks by field evidence is disappointingly difficult. Hence it will be convenient to reverse the normal order of procedure, and describe the petrography of the Macedon rocks before dealing with their relations in the field.

The igneous rocks of Mount Macedon may be divided into six groups:—

1. Grano-diorites
2. Geburite-dacites
3. Trachy-phonolites
4. Sölvsbergites
5. Andesites
6. Agglomerates and Ashes.

The rocks of the last five groups are those properly belonging to Mount Macedon; the association of the rocks of the first group is accidental, as they belong to the underlying Palaeozoic platform.

The following descriptions of the rocks are limited to features of geological significance. An account of the mineral constituents I hope to issue subsequently.

1. The Plutonic Rocks of the Palaeozoic Platforms.

Aplin's map marks the occurrence of three outcrops of "granite" in the Macedon area. The largest exposure lies along the south-eastern border of the Macedon series. An outlier occurs to the north of this main outcrop, and it also is on the boundary between the eruptive rocks and the Ordovician. The third exposure is low in the western slope, where a "granite" dyke is marked two and a half miles east-south-east from Woodend.

The south-eastern "granite" is well exposed on a ridge crossed by the road from Riddell's Creek to Cherokee's. The rock continues from the State school reserve at Mount Teneriffe on the south, to a low saddle half a mile south of Cherokee's. The rock is also well exposed on the ridge between the head of Kerr's Creek, (or Running Creek) and the Cherokee Road.

The rock, as Aplin remarked, varies considerably in character. A specimen from the ridge three-quarters of a mile south-west from Kerr's Mill, at the head of Running Creek, shows the following characters. The rock is of medium grain and holocrystalline. It consists of quartz, plagioclase and biotite. The quartz is in large blebs and some idiomorphic crystals; some of them have solidified before the biotite. The plagioclase is mostly oligoclase and belongs to two periods of consolidation; the crystals often consist of a worn, decomposed nucleus, restored by re-growth with the outer zones in optical continuity with the central part. The material of the nucleus has decomposed into an irregular granular aggregate, with numerous minute microlites of zoisite.

Biotite is usually abundant; it occurs in large well defined crystals, and in microliths, some of which occur in zones round the idiomorphic crystals of quartz and plagioclase.

The specific quartz of this rock is 2·8.

As a second example of the rock forming the south-eastern plutonic outcrop may be taken a specimen from the south-western margin at Hamilton's. The quartz is somewhat more abundant, but is all allotriomorphic. The predominant felspar is oligoclase, mostly occurring in irregular aggregates. There are also some larger, simply twinned felspar grains referable to orthoclase. The biotite at this locality is often decomposed into chlorites.

In some varieties of the rock from this plutonic mass hornblende is present, and it sometimes wholy replaces the biotite. The hornblende occurs in patches, in some of which it is fairly abundant. In the rock as a whole, however, the presence of hornblende is exceptional.

This plutonic rock was mapped by Aplin as granite, an identification supported by Selwyn, who described (19, p. 7, No. 51) it as a "binary granite." But the rock is allied to the diorites by the abundance of plagioclase and the scarcity of orthoclase. It is a typical member of that series of Vicorian plutonic rocks that have been described by Howitt (*e.g.*, 7, p. 31) and accepted by Rosenbusch (17, vol. i., p. 231) as quartz-mica-diorites. The rock is sometimes a quartz-amphibole-diorite.

The rocks of this series differ from the typical European quartz-mica-diorites, *e.g.*, that of the Val Camonica, in the nature of the felspar. The alkali felspar is far more abundant than in the true diorites, which are characterised by the predominance of the basic felspar. The Victorian rocks are intermediate between the normal granites and diorites. We may therefore conveniently adopt for them the name of grano-diorite, which has recently been widely used in America for the similar rocks of the Sierra Nevada.

The preceding description of this grano-diorite is necessary, because a passage from it to the "traps" of the Macedon series has been generally maintained. Murray, for example, states (14, pp. 22, 23) that "in all these instances [*i.e.*, Macedon, Dandenong, and Healesville] there seem to be no clearly defined lines of demarcation between the rocks classed as trap and the adjacent granites, while in some places a gradual passage from one to the other, as regards mineral composition, is observable, and the different forms appear to blend with one another as though they were simply rocks of varying mineralogical structure belonging to the same general mass."

However, I could find no trace of passage from the plutonic to the eruptive rocks. Half a mile south of Cherokee the two rocks can be seen close together. Both present their normal characters up to the junction. The comparatively coarse grained quartzose rock underlies the compact dark green Macedon rock, and neither Mr. Grayson nor myself could find any intermediate variety.

The relations of the two rocks can be best explained by the Macedon rock covering the surface of an older plutonic rock.

Petrographically there is nothing especially to connect the grano-diorites and the rocks of the Macedon eruptive series. Most probably the grano-diorite was intrusive into the Ordovicians, and is simply part of the old Palaeozoic platform. The grano-diorite, therefore, belongs to a much earlier period than the Macedon eruptions.

This view, however, would be refuted if Aplin's map be correct as to the "granite" dyke on the western flank of the mountain. This dyke is marked as running from the south-eastern corner of allotment No. 22, almost due south-east toward the summit of the south-western shoulder of Macedon. The dyke is 2½ miles east-south-east from Woodend. In a short search for this granite I failed to find any plutonic rock; but, in what appeared to me the corresponding position, is an unusually coarse-grained variety of the Macedon dacites. The occurrence of a granite dyke cutting through the traps would certainly prove that the "granites" (in Aplin's sense of the term) were later than the Macedon eruptive rocks. But, unless I failed to find Aplin's dyke, the rock has no connexion with the grano-diorites exposed on the eastern flanks of Macedon.

2. THE ROCKS OF MOUNT MACEDON SERIES.

The rocks of the Macedon series may be divided into five groups: (1) a series of hypersthene-dacites, which for reasons related on p. 202 are described as geburite-dacites; (2) trachy-phonolites; (3) sölvsbergites; (4) alkaline-andesites; (5) agglomerates and ash.

a. THE GEBURITE DACITES.

The main bulk of Macedon is formed of a fine-grained rock which, when fresh, is tough and varies in colour from dark green to black speckled with grey or pinkish spots. The rock weathers brown or pinkish-red. Examined microscopically the rock shows two main varieties; the first ranges in structure from granulitic to pilotaxitic; the second variety is hyalopilitic.

As types of this series of rocks we may take the following:—

1. *Willimigongong Type.*

Neighbourhood of Upper Macedon.

(a) Willimigongong Creek, near junction with the Ordovicians; opposite Cheniston (No. 25).

This rock is seen, when examined microscopically, to be porphyritic, consisting of well developed, abundant phenocrysts in a hypidiomorphic, granulitic base. The phenocrysts consist of plagioclase and pyroxene.

The plagioclase phenocrysts are usually irregular and corroded; but in some the outline is regular and the angles are sharp. The twinning is coarse and is on the albite type, often combined with the carlsbad type. Zonal growth is commonly shown, but no undulose extinction. Basal cleavage fragments show extinction of 22° on the edge 001/010; but in one case the extinction angle was 28°; hence the plagioclase phenocrysts include members of the bytownite series.

The pyroxene phenocrysts are mostly of hypersthene, which shows the typical pleochroism. The mineral is abundant and often has regular crystal outlines. The crystals are smaller than the larger bytownites. A few corroded crystals of monoclinic pyroxene occur.

Ilmenite is abundant and occurs in well developed crystals, often as large as the hypersthenes.

The base of the rock is partly a granulitic mosaic of felspar and quartz and partly a pilotaxitic mixture of the same constituents. The separation of the two minerals in the granulitic patches is difficult, but the presence of quartz is shown by the uniaxial character of some of the granules. The larger plagioclase microliths show simple or multiple twinnings, and have straight extinctions. The majority are oligoclase. Small biotite crystals occur in zones around some of the larger felspars in the base, and some of it is scattered irregularly through the base.

An analysis of this rock is given on page 201. The specific quartz is 2·78.

(b) Cheniston. On the south-eastern slope of Mr. H. R. Hogg's house at Macedon is an outcrop of a similar rock. The base is granulitic; there is no trace of fluxion structure; plagioclase laths in the base are scarce. The phenocrysts are more crowded than in the rock previously described; they include quartz in small corroded crystals. Biotite is more abundant and is often altered to chlorite.

(c) South of the Schoolhouse. A rock (No. 26) similar to the last variety occurs a couple of hundred yards south of the Upper Macedon schoolhouse.

(d) Mount Towrong Spur. The rock exposed along this Spur agrees in the main with the Willimigongong variety, but has more crowded phenocrysts and more abundant quartz. The rock at the summit of Mount Towrong has many broken phenocrysts with the angles of the fragments sharp and unworn. The quartz contains many apatite needles; the ilmenite is in large hexagonal plates. The hypersthenes are often deeply corroded by the granulitic base.

This spur ends to the north in a platform beside the source of the Willimigongong south of the Camel's Hump. A branch track runs eastward to Lady Carnarvon's Tree from the main track between the Creek and the Camel's Hump. The rock exposed near the junction of the two tracks has several interesting features. Parts of slides cut from it appear almost brecciated from the abundance of angular, fragmentary phenocrysts. The hypersthenes are large and include plagioclase microliths. The ilmenite is sometimes surrounded by an aureole of biotite. Some of the larger biotites are partially altered to chlorite. The base is granulitic, and has no trace of fluidal structure.

(e) North face of Macedon. The Willimigongong type may be seen at many localities on the north face, especially around Braemar; at the foot of the north-

eastern buttress and along the road between the last-named point and the foot of the ridge south of the Hanging Rock.

A variety of the dacites intermediate between the Willimigongong and the merocrystalline types occurs at the southern end of the Upper Macedon Spur. It is exposed on the slope between Mr. H. R. Hogg's house, Cheniston, and the Willimigongong. The rock is holocrystalline and porphyritic with phenocrysts of plagioclase and hypersthene, and some quartz. The base under a low power in ordinary light appears glassy with an incipient fluidal structure due to the banded distribution of minute greenish microliths. The largest of these microliths are hypersthene; the remainder are probably also hypersthene, but they are too small to show pleochroism or admit of certain identification. The rest of the base is doubly refracting and consists of a felt of plagioclase laths with granules of quartz and plagioclase.

The main difference between the Cheniston and the Willimigongong types is that the former shows a passage from a granulitic to a pilotaxitic structure.

A second representative of this type is the rock (38) at Cherokee's, near the junction with the grano-diorites. In this case an incipient fluidal structure is due to the flakes of biotite. This mineral also occurs in radial tufts around the ilmenite and is more abundant than in most of the Macedon rocks. The base is granulitic, passing in patches to pilotaxitic.

2. *The Cheniston Type.*

Associated with the granulitic Willimigongong dacites is a rock that weathers light brown and greyish, and then appears tuff-like, owing to the occurrence of angular felspar fragments in a light earthy base.

As an example of this rock may be quoted that exposed on the roadside by the entrance to the carriage drive at Cheniston.

When examined microscopically this rock is seen to have a hyalopilitic structure. The phenocrysts are irregular aggregates of bytownite granules and of corroded isolated crystals of the same material. The hypersthene has been altered and is stained with limonite. Chlorite is present as an alteration product after the hypersthene. The base has a well developed fluidal structure shown by the arrangement of the plagioclase laths; it contains patches of material of an earlier consolidation in which the structure is pilotaxitic or subgranulitic.

Hence this rock agrees in composition with the Willimigongong type and began to solidify under the same conditions; but its final consolidation occurred after it had undergone a definite flow.

b. THE TRACHY-PHONOLITES.

The rock (No. 28) that crosses the valley of the Turritable Creek and forms the waterfall a little to the west of the State school at Upper Macedon is the most convenient type of the trachy-phonolites.

The rock is dark green in colour, and is porphyritic, with large phenocrysts of anorthoclase, showing the typical minute twinning of that species. The base is full of fluidally arranged felspar laths, which are either simply or repeatedly twinned. They also are probably anorthoclase. Sparsely scattered through the rock are small crystals of aegerine, which show the typical pleochroism of green and greenish yellow; they are about as long as the longer felspar laths in the base. Between the laths is a somewhat altered green glass, which in places is arranged in vermiculitic growths and elsewhere occurs as radial globules, which show a black cross under crossed nicols. An isotropic mineral, which gives some hexagonal sections, and the green glass both give gelatinous silica when treated with hydrochloric acid. Evaporation of acid that has acted on this mineral. Mineral yields a few gypsum crystals, so that it is no doubt nosean. Ilmenite in large flakes is sparsely scattered, but in places it occurs in clots.

This rock has been analysed by Mr. R. J. Lewis; the analysis (No. 2, p. 201) in conjuction with the microscopic evidence shows that the rock is a trachy-phonolite.

Another exposure of this rock (No. 33) occurs in a small quarry to the south of the waterfall and near the junction with the underlying Ordovicians. The rock is porphyritic and hyalopilitic in structure. It contains phenocrysts of anorthoclase showing marked undulose extinction and extremely fine twinning. Some green glass, a little nosean, and abundant ilmenite also occur. The fluxion structure is well developed and there are a few vesicles filled with green-stained silica.

c. THE SÖLVSBERGITES.

The third member of the Macedon rock series forms the Camel's Hump and two outliers in the plain to the north.

The rock of the Camel's Hump is the best known geologically, as it was analysed by Newbery, and is the type of the "felspar porphyry" or "syenite porphyry" of the Geological Survey.

The rock is greyish brown in colour, and consists, in the main, of large phenocrysts of anorthoclase, set in a fluidally arranged series of lath-shaped felspars, which may be either soda-sanidine or anorthoclase. Some of the phenocrysts have been fractured, and the edges are quite sharp and uncorroded; hence the rock probably became thick and semi-viscous before consolidation, and has not flowed far from its vent. In the interspaces between the felspars are mossy patches and groups of small crystals of aegerine and riebeckite. The aegerine is more abundant and occurs in larger crystals than the riebeckite; the latter is, however, conspicuous from its fine blue colour and strong pleochroism.

Similar in form to the riebeckite, but in smaller and rarer patches, is a dark brown to opaque mineral, which Mr. Prior has kindly identified as cossyrite. It is strongly pleochroic and the grains are angular or subangular.

The rock on the southern side of the Camel's Hump is somewhat fresher. The aegerine, riebeckite and cossyrite, though minute, are often idiomorphic; but in places these minerals are moulded on the felspars. Ilmenite, including small zircons, occurs. The biotite is sometimes intensely corroded, and some zones have been changed to chlorite.

The Hanging Rock, which rises from the plain at the northern foot of the Macedon ridge is closely allied to the rock of the Camel's Hump; but the fluidal structure is less defined. The felspar laths of the ground mass tend, moreover, to occur in short broad prisms rather than in long laths. The interspace between the felspars is occupied by a granular felspar mosaic.

Aegerine is abundant in small angular grains and prisms, which are crowded round the anorthoclase phenocrysts. The riebeckite is in larger crystals than in the rock of the Camel's Hump.

Nosean, in corroded crystals and biotite, also occur, though sparingly; the crystals of the latter are fringed with aegerine prisms.

d. THE ANDESITES.

On the plains to the north and north-west of Mount Macedon are occasional exposures of weathered rock containing numerous black specks in an earthy grey base. The best exposure is in a small quarry on a hillock in allotment No. 84 in the north-eastern corner of Woodend. The rock is included on the Geological Survey Map as a member of the Cainozoic basalts. As, however, the rock (No. 35) contains anorthoclase, some altered nosean and altered olivine, it is a member of the Macedon series and not of the later basalts. I have not yet succeeded in getting fresh specimens of this rock, and postpone a fuller account of it until better material is available.

e. AGGLOMERATES AND ASHES.

Exposures of pyroclastic rocks are rare on Mount Macedon. Denudation has probably removed most of them, and what remain now occur in depressions between the more resisting dykes and lavas.

The best example of agglomerates that I have yet found occurs at Upper Macedon on the roadside leading from the lodge at Government Cottage to Mr. Justice Hood's house near the State Nursery. The best section is at the height of about 400 feet above the Turritable Creek and a little below some land that belonged to the late Sir F. McCoy. Here occurs a band of agglomerates with blocks of the geburite-dacites up to 4 feet in diameter included in fine ash. Further up the road is an exposure of volcanic ash traversed by a ten-foot dyke of geburite-dacite.

Well developed tuffs occur in other parts of the Macedon range, as *i.e.*, at Cherokee.

V.—Chemical Composition.

Three analyses of the Mount Macedon rocks have been prepared. The sölvsbergite from the Camel's Hump was analysed by Newbery. By the kind permission of Professor Orme Masson, analyses of the Willimigongong dacite and the trachy-phonolite of the Turritable Waterfall have been made by Mr. R. J. Lewis in the University Laboratory. The analyses are given on page 201. For comparison with them are given analyses of dacites from Dandenong and the Black Spur, and of a granodiorite, also from Dandenong, for which I am indebted to the Government Metallurgist, Mr. H. C. Jenkins, A.R.S.M. To Dacia Doelter's analysis of the latter is quoted in column No. 13 show the differences between the geburite-dacite and the dacite of In comparison with the trachy-phonolite of the waterfall may be quoted vom Rath's analysis of the rock from Scarrupata in Ischia.

Prior's analysis of a sölvsbergite from Abyssinia is given in column No. 11.

	Macedon.					2 Miles N. of Dandenong Township.							
	Sölvsbergite, Camel's Hump.	Trachy-phonolite, Turritable Waterfall.	Geburite-Dacite. Willimigongong.	Dandenong Dacite.	Black Spur Dacite.	Porphyrite.	Porphyrite.	Grano-diorite.	Grano-diorite, Omeo.	Orthophyre, Omeo.	Sölvsbergite. Eddi Gijorgis, Abyssinia.	Trachy-phonolite. Scarrupata, Ischia. vom Rath.	Dacite. Doelter.
	1	2	3	4	5	6	7	8	9	10	11	12	13
SiO_2 -	65·97	62·72	64·38	67·25	65·80	64·0	65·05	63·38	65·59	69·04	63·74	65·75	66·32
Al^2O_3 -	18·11	16·27	13·62	16·38	16·87	19·11	10·04	17·36	17·46	18·14	17·86	17·87	14·33
FeO -	4·82			1·30	1·08	2·80	5·14	1·98	·10		·30	4·25	·25
Fe_2O_3 -	trace	6·83	9·17	4·62	3·97	2·22	8·47	1·61	4·21	·53	4·27		5·53
FeS -						1·58	1·35	3·38					
MnO -				·33	trace						·19		
CaO -	·98	1·06	1·99	3·05	3·16	5·13	4·80	4·18	1·03	·44	·83	1·33	4·64
MgO -	trace		2·18	1·76	1·76	2·17	trace	1·80	2·35	·27	·10	·52	2·45
K_2O -	trace	4·99	3·51	1·36	2·54	·14	·02	·31	2·89	5·10	5·19	3·48	1·61
Na_2O -	10·17	8·47	6·28	2·56	3·45	1·12	3·39	4·07	4·10	7·12	7·23	5·67	3·90
H_2O -	·56			·30	1·05	1·01	·56	·54	1·98	·35	·83	·78	1·13
CO_2 -				1·56		1·71	1·53	1·13					
	100·61	100·34	101·13	100·47	99·68	101·19	100·35	99·74	99·71	100·99	100·54	99·65	100·16

VI.—The Relations of the Macedon Rocks.

After the foregoing account of the rocks of the Macedon series, we may proceed to consider their general petrographic relations. In the first place it is clear that the rocks, excluding the grano-diorite, are part of one petrographic series, having been formed by differentiation from one magma. They all belong to the intermediate group, and are characterised by a high percentage of soda. The three rocks that have been analysed vary from 62·7 to 65·9 % of silica, and from 9·79 to 13·46 % of alkalies. The soda varies from 6·28 % in Mr. Lewis's analysis of the Willimigongong rock to 10·1 % in Newbery's analysis of the rock of the Camel's Hump. The microscopic examination, showing the predominance in the superficial member of the series of anorthoclase, aegerine, nosean, riebeckite and cossyrite (aenigmatite), agrees with the chemical analysis, and shows the abundance of soda in the rock.

That the grano-diorites are not members of the Macedon series is shown by the absence of passage rocks, and of the typical minerals of the Macedon group from the diorites. The Macedon effusive rocks are not those that would have been formed by eruption from the grano-diorites that underlie them on their south-eastern margin. The plutonic representative of the Macedon lavas is probably a nepheline-diorite, which has not been found in Victoria.

The member of the Macedon series which originated at the greatest depth is the Willimigongong type of dacite. It occurs in big intrusive dykes or masses along the Willimigongong, at Cheniston, Towrong, Braemar, Cherokee, etc. ; in fact wherever denudation has cut at all deeply into the Macedon block.

The microscopic examination of this rock at first suggests for it the name of hypersthene-andesite, as hypersthene and a fairly basic plagioclase are the two most striking constituents. The abundance of free quartz in some sections, however, necessitates its inclusion among the dacites. The term hypersthene-dacite would, however, alone be inadequate. The facts that the rock is holocrystalline and that it occurs in intrusive dykes are not final objections, for Rosenbusch accepts (17, vol. i., p. 450) a group of holocrystalline dacites. The most serious objection is that the normal dacites contain an excess of alkaline earths over alkalies, and far less alkali than the Macedon rock. Thus Doelter's analysis of the typical Dacite of Transylvania gives 66 % of silica, 7·1 % of lime and magnesia, and only 5·5 % of soda and potash. The Macedon rock contains 64·3 % of silica, 4·1 % of lime and magnesia, and 9·8 % of soda and potash. A comparison of the mean molecular composition of the dacites quoted by Loewinson Lessing (11, p. 449) with that of the Macedon rock is shown by the following table, which also gives the nearest analysis to the latter.

——	SiO_2	Al_2O_3	Fe_2O_3 and FeO	CaO	MgO	K_2O	Na_2O
Dacite (mean of twelve analysis	1·123	0·158	0·042	0·068	0·035	0·020	0·071
Willimigongong Creek	1·086	0·133	0·057	0·035	0·054	0·037	0·101
Teolo, Euganean Hills	1.111	0.137	0·079	0.029	0·003	0·034	0·127

In Rosenbusch's series of analyses of Dacites, no rock is given with so high a percentage of alkalies as we find at Macedon. In his sixteen analyses (18, p. 286) the highest percentage of soda and potash together is 7·95, in the rock to which he gives the precise but lengthy name of "quarzbiotithronzitaugitporphyrit"; the highest percentage of soda is 4·06 against 6·28 in the rock from Willimigongong.

The name dacite alone is unsuitable, for the dacites are eruptive members of the quartz-diorite group and this Macedon rock is certainly part of a sequence of which the best developed lava is a member of the tinguaite group. The name, moreover, would be locally inconvenient, for normal dacites appear to be extensively developed in Victoria, and it would be inadvisable to include the two rocks under one name. Hence I propose to refer to the fundamental rock of the Macedon range as geburite-dacite, Gebur being the native name of Mount Macedon.

The geburite-dacites may be defined as intrusive or effusive dacites, distinguished from the normal dacites by the rarity of quartz and the great excess of alkalies, especially of soda. The

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The geburite-dacites may be defined as intrusive or effusive dacites, distinguished from the normal dacites by the rarity of quartz and the great excess of alkalies, especially of soda. The predominating structure of the ground mass is granulitic; hypersthene is the most abundant ferro-magnesian constituent.

The typical geburite-dacites form thick dykes. The effusive rocks of Macedon may be divided into four main groups. The first is the geburite-dacite, with hyalopilitic structure, such as occurs around Cheniston. The second group may be called trachy-phonolites; they are characterised by the abundance of anorthoclase, and the replacement of hypersthene by aegerine; they probably also occur as dykes. The rock at the Turritable Waterfall is the best type of this group. The rocks of the next group are hyalopilitic with well developed fluxion structure. The minerals are anorthoclase, riebeckite, cossyrite and aegerine, and the rocks may be identified as sölvsbergites. Newbery's chemical analysis of the Camel's Hump rock agrees with that of the typical sölvsbegites.

To the last rock of the Macedon series I feel at present doubtful about applying a definite name, not having secured a fresh specimen. The rock is exposed in a shallow quarry at the north-eastern corner of Woodend. It was included by Aplin among the basalts of the Newer Volcanic Series. The rock is no doubt more basic than the other members of the Macedon series, for it contains what appears to be altered olivine. The rock may be left for the present as an alkali-andesite.

The rock sequence at Mount Macedon, therefore, ranges from holocrystalline dykes of geburite-dacite to a series of effusive rocks including trachy-phonolite, sölvsbergite and alkali-andesite.

The order of the minerals in this rock sequence is well marked. The geburite-dacites contain abundant hypersthene, and some corroded phenocrysts of bytownite. In the trachy-phonolites the hypersthene has been replaced by aegerine, and the basic plagioclase by anorthoclase. In the sölvsbergites the abundance of soda is expressed by the development of the riebeckite and cossyrite in addition to the soda minerals of the trachy-phonolite. The last stage in the series is marked by the occurrence of what is probably altered olivine in the andesites of the northern margin of the Macedon series.

The foreign rocks most nearly allied to those of Macedon are not found among the dacites, but in the series of rocks from the Kristiania district made famous by Brögger's searching investigation. The Macedon sölvsbergites, though resembling those of Southern Norway, have not been derived from the same magma. The Kristiania sölvsbergites have been formed by differentiation from laurdalite, a plutonic rock composed of anorthoclase, cryptoperthite, elaeolite, lepidomelane, and a monoclinic pyroxene. In spite of the very varied series of rocks that has been developed from the laurdalit magma, it does not include any equivalent of the soda-hypersthene-dacite, which is the lowest exposed rock at Macedon.

A second series of allied rocks occurs in Abyssinia. The rocks have been described in a valuable paper by Mr. E. T. Prior; but these rocks are said to be a dyke series, and there is no close ally of the geburite-dacites.

VII.—The Geological Structure of Mount Macedon.

The dense forest growth that covers Mount Macedon obscures the mutual relations of its rocks. Nevertheless, by piecing together the evidence of many parts of the area the general arrangement can be determined.

The best idea of the structure of Mount Macedon can be obtained by a traverse north and south across the ridge from the township of Macedon on the south over the Camel's Hump and thence through Hanging Rock to the village of Newham on the north.

In such a traverse we find the first exposures of igneous rocks on the northern side of a branch of the Saltwater River and to the north-east of Macedon cemetery. Here the geburite-dacites rest on the Ordovicians. The igneous rocks are exposed in a small quarry, in occasional hummocks in the forest, and in the bed of the Turritable and Willimigongong Creeks. The dacites have a well-developed fluxion structure where they rest on the Ordovicians; but in the main mass of the eruptive rock the structure is holocyrstalline and granulitic. On the lower slopes of this part of Macedon there are dykes of trachy-phonolite and geburite-dacites; but the field relations of these dykes are not clearly shown. Continuing the ascent towards the main ridge we pass over some agglomerate and ash traversed by dykes, and then over thick effusive masses, as well as some apparently intrusive bands of geburite-dacites. On the platform immediately south of the Camel's Hump there are exposures of geburite-dacites of the Willimigongong type, upon which rests the hummock of the Camel's Hump sölvsbergite. This rock is jointed and weathers spheroidally. It appears to be part of a sheet that flowed southward. But there is no trace of the vent, for the rock is abruptly cut off by the steep northern face, which, below the sölvsbergite, consists of geburite-dacite. At the foot of the northern face is the valley of the Five Mile Creek ; the floor is covered by alluvium. Beyond this is the Hanging Rock, a hill of sölvsbergite, which rises 360 feet above the surrounding plain. The rock is very coarsely jointed and is in places irregularly columnar ; it has been worn into great hollows by the ready decomposition of the soda silicates and the removal of the insoluble residue by the wind.

The Hanging Rock is probably part of a sheet discharged from a vent a little to the south ; but the vent may be hidden under the site of the hill. North of the Hanging Rock is a plain of andesite, which in places rises into hills such as the Jim Jim or Dryden's Hill. The andesite is covered in places by the basalts ; and the line of demarcation between these rocks is indefinite, although the country is open. The apparently intimate field relations of the Macedon andesites and the basalts suggests that there is no very great difference in age between them.

It was from the supposed great antiquity of the Macedon rocks that they were called "traps." According to Page's[1] definition, the word "is now employed by geologists to embrace all the multifarious igneous rocks that belong to the Palaeozoic and Secondary epochs, as distinct from the more ancient granites on the one hand and recent volcanic rocks on the other."

It was apparently in this sense, and not in the original meaning of a number of sheets of igneous rocks forming a succession or steps (*trappa*, a step), that the word trap was adopted by the Victorian Survey ; for the English Survey thus used the term in its work in North Wales, where Selwyn received so much of his training.

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[1] Page, Handbook Geological Terms, 1865, p. 442.

The Macedon rocks were therefore called traps, because they were regarded as forming a palaeozoic plutonic massif; although it was recognised that their aspect was not typically plutonic.

The theory that Mount Macedon is a plutonic massif is disproved by the absence of contact metamorphism and of disturbance in the adjacent Ordovician rocks. There are traces of contact alteration in the district; but they may be due to the intrusion of the grano-diorites. In several places the Ordovician rocks may be seen close to the junction with the Macedon series. Yet there is neither contact alteration nor disturbance of strike; and both changes must have happened had so great an igneous mass as Macedon been directly intruded into a series of sediments.

The relations of the geburite-dacites to the underlying Palaeozoic platform may be illustrated by the two following cases:

1. *Upper Macedon Spur.*

The Macedon township ridge which lies between the Turritable and the Willimigongong Creeks, ends to the south below a band of alluvium along one of the western branches of the Saltwater River. On the northern bank of this stream the Ordovicians can be seen outcropping below the geburite-dacites and trachyphonolites. The sedimentary beds can be traced along the southern margin of the Macedon rocks and up the courses of the Willimigongong as far as Cheniston, and for a short distance along a branch of the Saltwater a little to the west of the Turritable Creek. The Ordovician beds show no contact metamorphism and their strike is not disturbed. The junction of the sedimentary and igneous beds along the south is from the level of 1600 to 1625 feet. On the eastern side of the Macedon township ridge the Ordovician beds run further to the north to a height of 1940 feet in the "Knoll" near Cheniston.

The relations of the two rock series show that a lobe of geburite-dacite has flowed quietly southward from a vent to the north over an irregular surface of the Ordovicians.

This conclusion is in agreement with the evidence of other parts of the Macedon margin. A mile and a half to the east of the Hanging Rock is an inlier of the Ordovicians running along the continuation of the north-eastern buttress of the main ridge. The Ordovicians outcrop here as denudation has exposed the summit of an old ridge of grits and sandstones. The Ordovicians are flanked on both sides and on the south by geburite-dacites; on the sides the dacites are at a lower level than the Ordovicians (Fig. 3.) At the northern end of this inlier the Ordovicians are covered by a boss of basalt which forms a bare hump (2200 feet high) crossed by the main road between paddocks Nos. 9 and 17 on the parish map of Newham.

The Ordovician rocks are neither altered nor disturbed by the dacites.

The relations of the two series may be best explained by a flow of dacites from the south having buried a meridional ridge of Ordovicians.

The evidence of these two cases shows that Mount Macedon is not a plutonic massif. The second explanation that suggested itself was that the mountain might be a laccolite, a view supported by the apparent absence of tuffs and the general form of the igneous mass. I could find no definite evidence in favour of this view, and finally the discovery of beds of pyroclastic rocks traversed by dykes show that this explanation was unnecessary.

This evidence leaves no doubt that Mount Macedon is the worn stump of a great volcano. There is no trace of a crater, and the superficial beds of ash have been removed by denudation. The fragmentary material was probably never very abundant, for lavas formed most of the volcanic pile. Like the phonolite domes of Europe, the richly alkaline lavas of Macedon probably welled forth quietly with only occasional explosions. The eruption therefore formed a dome-shaped hill of lava with but few interstratified ash beds. The first eruptions were of geburite-dacite, which forms the main mass of the mountain. The sölvsbergites and trachy-phonolites were then discharged from secondary vents on the flanks and probably also from the main crater. The soda-andesites of the north-western flanks were then erupted. Finally the Macedon eruptions ceased and the volcanic forces found vent in the discharge of the basalts that now cover the surrounding plains.

The section (Fig. 4) shows a transverse section across Mount Macedon; but owing to the denseness of the forest and scrub only a diagrammatic section is at present possible.

The original crater must have been far above the present summit of the mountain, which may once have risen 5000 feet above the underlying Palaeozoic platform. It is now only the basal stump of a volcano, in which all traces of the crater have been lost, but which has not yet been sufficiently dissected to show the rock of the central core.

VIII.—Allied Eruptive Centres in Victoria.

Before considering the place of Mount Macedon in the volcanic history of Victoria it will be convenient to refer to the distribution of allied igneous rocks in the State.

Rocks rich in soda are widely distributed here both in time and place. Mr. Howitt has described (6, p. 38) an orthophyre from Omeo with 7·12 % of soda; the rock is assigned to the middle palaeozoic.

Petrographically the Victorian rocks most closely related to the geburite-dacites are some dykes traversing the Ordovician beds at Bendigo. They were originally described as limburgites, and have been referred by Mügge to the monchiquites. I have not been able to see the slides described by Mr. Howitt, from the 180 Mine; but some dykes collected at the Eaglehawk Mine are monchiquites, though in places rendered abnormally acid by the infiltration of secondary silica. The only certain fact as to the age of these dykes is that they are post-Ordovician; but Mr. Howitt has suggested that they are in all probability connected with the Cainozoic basalts. Petrographically it is probable they are of the same age as the Macedon eruptions.

The Victorian rocks with which the Macedon series is most allied geologically are the great eruptive masses of the Upper Yarra and the southern tributaries of the Goulburn. The masses in question are formed of dacites and constitute the mountains of Dandenong, the Cerberean Range, the Blacks' Spur, near Healesville, and possibly an independent centre between Mount Arnold and Warburton.

A description of a few of these rocks will illustrate their affinities to the Macedon series.

Mount Dandenong consists of a hypersthene-biotite-dacite. The quartz is more abundant and occurs in larger phenocrysts than in the geburite-dacite. Biotite is also more abundant. Hypersthene occurs in large corroded phenocrysts, and there are rare crystals of augite. The predominant felspar is apparently andesine. The base is granulitic. I have not found any trace of aegerine or riebeckite in this or any other of the Dandenong rocks examined. An analysis prepared by Mr. Jenkins shows that the rock is normal in alkalinity. This rock appears to form the main mass of the Dandenong hills, and it is associated with tuffs of the same mineral composition.

The Blacks' Spur, between Healesville and Narbethong, is another dacite dome. A specimen from the summit of the ridge has been analysed by Mr. Jenkins, and the results show that the rock has a very similar composition to the Dandenong dacite. The microscope shows that the petrographic characters are practically identical.

At the northern foot of the Blacks' Spur the dacites rest on grano-diorite. In order to test whether there be any passage rocks between the two, I have examined the rocks nearest to the junction that I could find.

A small quarry at the bend of the road close by the gateway to Mr. Lindt's house, the Hermitage, is the most convenient type of the dacites near the grano-diorites. The rock is much decomposed. It consists of abundant quartz phenocrysts, which are deeply embayed by the ground mass; there are numerous flakes of biotite altered to chlorite, and of a pyroxene broken up into chloritic aggregates. The base is a weathered glass, which shows well marked fluxion structure. That the rock was flowing in a thick viscous condition is indicated by the fragments of fractured crystals remaining close together.

The rock is a weathered lava and is in no way intermediate between the dacite of the summit of the Blacks' Spur and the grano-diorite.

The Cerberean Range is also composed of dacite. I have only been able to examine the north-western edge of this mountain; but there it consists of dacites resting on an irregular surface of the Silurian and apparently also on the Cathedral sandstones. The rock is marked on the Survey Map as granite. But it is merocrystalline, and the base shows well marked fluxion. Quartz is abundant, and so also is biotite. There is no hypersthene. The felspar in part shows the minute twinning of anorthoclase.

In this respect, as in some others, the Cerberean rock is more nearly allied to the Macedon than to the Dandenong dacites. But, speaking generally, the dacites of the Upper Yarra and the Upper Goulburn differ from those of the geburite series by their lower alkalinity and the absence of the minerals riebeckite, aegerine, and nosean.

These different dacite masses appear to have similar stratigraphical relations. The Dandenongs, for example, rise above the plain of the Yarra as Macedon rises above its Palaeozoic platform. The dacites have not metamorphosed the sedimentary rocks which they overlie. For instance, the Silurians can be seen close to the dacite near the landslip on the road from Mooroolbark to the summit of Dandenong; the Silurian rocks appear quite unaltered.

It is true that in some places the Silurians are altered near the junction with the dacite; but there is no proof that it is the dacite that has wrought the change. It is more likely that the alteration has been caused by intrusions of grano-diorites and porphyrites, which have been injected into the Palaeozoic series.[1]

Mr. Ferguson has stated[2] that there is a gradual change from the "granites" to the "Dandenong traps"; but I have failed to find evidence of this, and Mr. T. S. Hart, who examined the sections on the Gembrook railway, tells me that wherever the two rocks could be seen together they were both greatly decomposed. He says there was no sign of a passage between the two rocks. This evidence is consistent with the view that the diorites and the dacites belong to different dates and had independent origins.[3]

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[1] Mr. Victor Stirling, it should be noted, has suggested that the alteration of the Silurian rocks at Lilydale is due to the traps. (No. 21, p. 10.)

[2] He states (3, p. 58) that where the trap and granite join "the one rock merges into the other without a break, the granite gradually getting more and more trappean in character till one rock gives place to the other."

[3] Since the paper was read I have examined the sections in question, and agree with Mr. Hart's conclusions.

Mr. Stirling (20, p. 29) may also be quoted in support of the view that the Dandenong rocks, which he calls mica-diorites, are much later than the underlying plutonic rocks.

IX.—The Age of Mount Macedon.

The stratigraphical evidence as to the age of the Macedon volcano is very incomplete. It was post-Ordovician; and it was earlier than the adjacent basalts, which belong to some part of the Upper Cainozoic. That is all that the available evidence positively proves.

The Geological Survey have regarded the mountain as Palaeozoic. But as Mr. E. G. Hogg has remarked (5, p. 96), no fragment of the Macedon rocks has been recognised in the glacial conglomerates of Bacchus Marsh and Heathcote. This negative evidence suggests that Macedon is later than the glacial series, which at the earliest is Upper Palaeozoic.

The thick Kerrie conglomerates which occur on the south eastern flanks of Macedon are considered by Mr. Hart (9, p. 66) to be probably earlier than the glacial series. No fragments of the Macedon rocks have been found in these beds, so that the dacites are probably later than the Kerrie conglomerates.

The only Cainozoic rocks with which the Macedon series is in contact are the basalts.

Mr. Knox, M.H.R., tells me that it has been suggested that some of the deep leads at Malmsbury originally flowed southward over the present site of Mount Macedon. I know of no direct evidence which renders this view either probable or impossible. The suggestion, however, is of interest, as showing that its author understood that Macedon is not a plutonic mass, and that it is not of Palaeozoic age. If this hypothesis be correct then Macedon is later than the beginning of the deep lead series of Central Victoria, and is at the earliest, according to current terminology, of "Miocene" age.

At present we can only conclude that Macedon is certainly post-Ordovician, most probably post-Palaeozoic, and certainly earlier than the upper Cainozoic. It may belong to any part of the Mesozoic or Lower Cainozoic. If the dacite series be Lower

Mesozoic, we may hope to find fragments of the Dandenong dacites in the South Gippsland coal measures. If it be found that there is no trace of the dacites in these deposits then the eruptions of the Macedon-Dandenong series are probably later than the Lower Mesozoic.

At present the evidence that gives the most plausible suggestion as to the approximate age of the Macedon eruptions is the association of the dacites and the basalts.

The basalts are now divided into two groups. The Newer Volcanic Series, the Pliocene of the Geological Survey, is Upper Cainozoic, and probably lasted till the human occupation of Victoria. The Older Volcanic Series, the "Miocene" of the Geological Survey, is probably Lower Cainozoic, and according to Messrs. Hall and Pritchard may have begun in the Cretaceous.

The great dacite eruptions are probably connected with the beginning of the Older Volcanic series. Some of the rocks which Aplin mapped as Pliocene basalts belong to the group which he mapped as Palaeozoic traps. To get an independent opinion on this point I showed Mr. E. T. Prior a thin section of the rock from the quarry north-east of Woodend, telling him it was mapped by the Victorian Survey as basalt. After a brief examination he expressed the opinion that the rock was evidently related to the Macedon series and was not a basalt.

I had come to this opinion in the field, and have not yet been able to determine the line of separation between the lavas of the Macedon series and the basalts. This close field association, therefore, suggests that the two igneous series are not so remote in age from one another as was thought.

It is probable that Mount Macedon was formed at the beginning of the great series of eruptions which ended in the formation of the great basalt plains of Victoria. It is not uncommon for a great period of volcanic activity to begin with the formation of lofty piles of lava belonging to the intermediate group and to end with the discharge of broad sheets of either acid or basic rocks. The volcanic history of the Yellowstone Park furnishes a classical illustration of this sequence. As Professor Iddings (10) has shown, a long period of quiet sedimentation, which lasted through the Palaeozoic and Mesozoic, was followed by the outburst of volcanic activity at the end of the Cretaceous. Domes of andesites—one of which, Crandall Volcano, was 13,500 feet high—were then piled up at intervals along a line 170 miles in length ; then followed a short rest, during which the andesitic cones were denuded ; finally came a period of fissure eruptions discharging sheets of basalt and rhyolite. The volcanic history of British East Africa shows the same general sequence, from the great dome of the kenytes to the basalts and trachytes of Laikipia and the Athi.

The volcanic history of Victoria may be found to have passed through the same stages. During the Palaeozoic there were periods of great volcanic activity, especially in the Devonian system. Then followed a long period of quiescence, succeeded, probably in the late Mesozoic or early Cainozoic, by a renewal of volcanic activity. Great dacite domes were formed at several centres—Macedon, Dandenong, the Cerberean Ranges, and the Blacks' Spur. After they became extinct the surrounding lowlands were devastated by the eruption of the basalts of the plains.

Hence it is not improbable that Mount Macedon is one of the volcanic piles that mark the beginning of the great period of volcanic activity, of which the last eruptions built up still existing craters, and are recorded in the legends of the Victorian aborigines.

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